

Assimilation of GPM GMI Rainrate Product with Community GSI and Case Study Result

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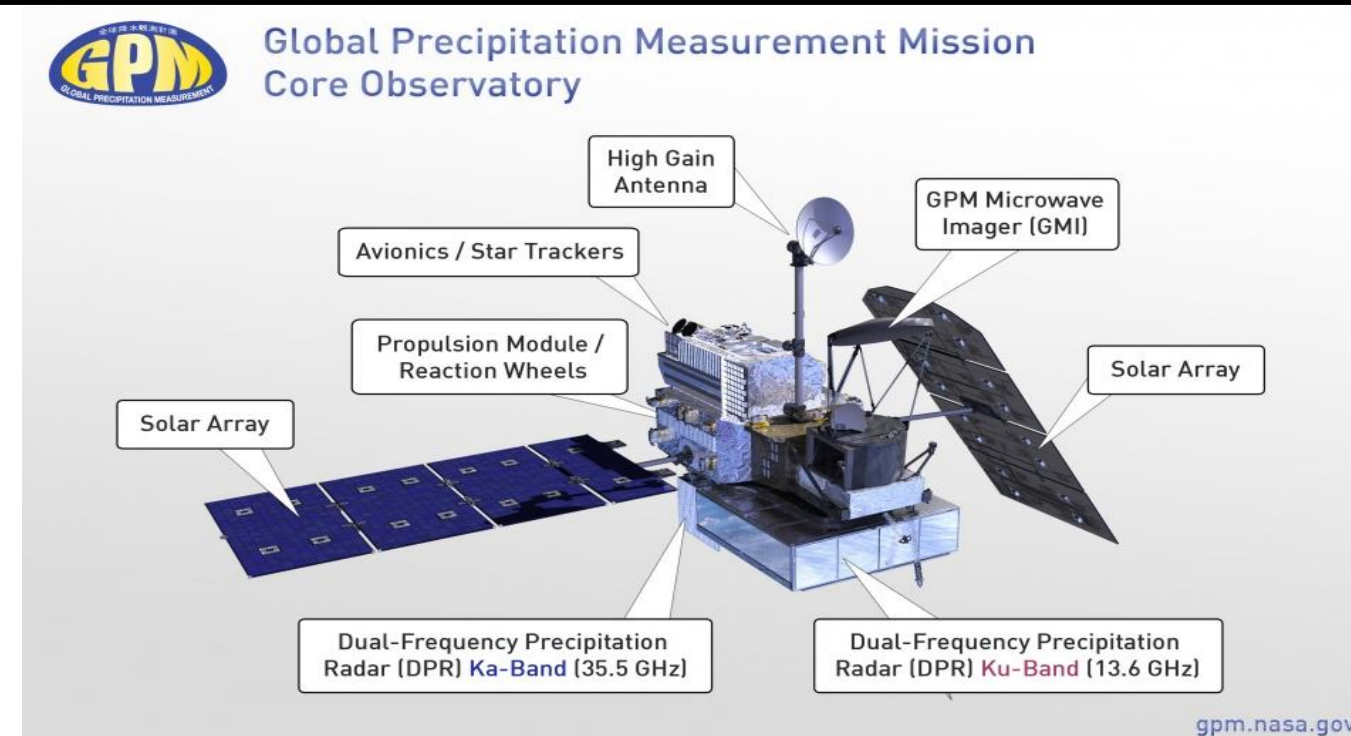
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Global Precipitation Measurement (GPM)



GPM: http://www.nasa.gov/mission_pages/GPM/main/

- Built upon Tropical Rainfall Measuring Mission (TRMM) legacy for next-generation global observation of rain and snow.
- Launched February 2014, Dual-frequency Precipitation Radar (DPR) and GPM Microwave Imager (GMI) data are available.
- Broad global coverage ~70°S – 70°N.
- Ka (35.5 GHz)/Ku (13.6 GHz) band radar with 245/125-km swath, and 13-channel GMI with 850-km swath: Better retrievals for heavy, moderate, and light rain and snowfall.

Project Goals:

- To develop methodology to implement GPM GMI GPROF surface precipitation data with GSI and WRF model
- To investigate the potential and the value of utilizing GPM observation into NWP for operational environment.

Rainrate Data Assimilation Physics Processes

Model and Data Assimilation System:

WRF ARW V3.5.1
Community GSI v3.5

Experiments:

Case study:
2014-05-15 heavy rainfall event
WRF model domains:
Outer: 15-km covering CONUS
Inner: 5-km focusing on northeast US

Data:

GMI 2AGPORF retrieved
surface precipitation rate

Experiments:

CTRL: no data assimilation
DA: GMI rainrate assimilation

GSI Physics Forward Model for Rainrate Assimilation:

- Large scale convection
- Grid scale precipitation

Convective Precipitation: Pan and Wu (1995)

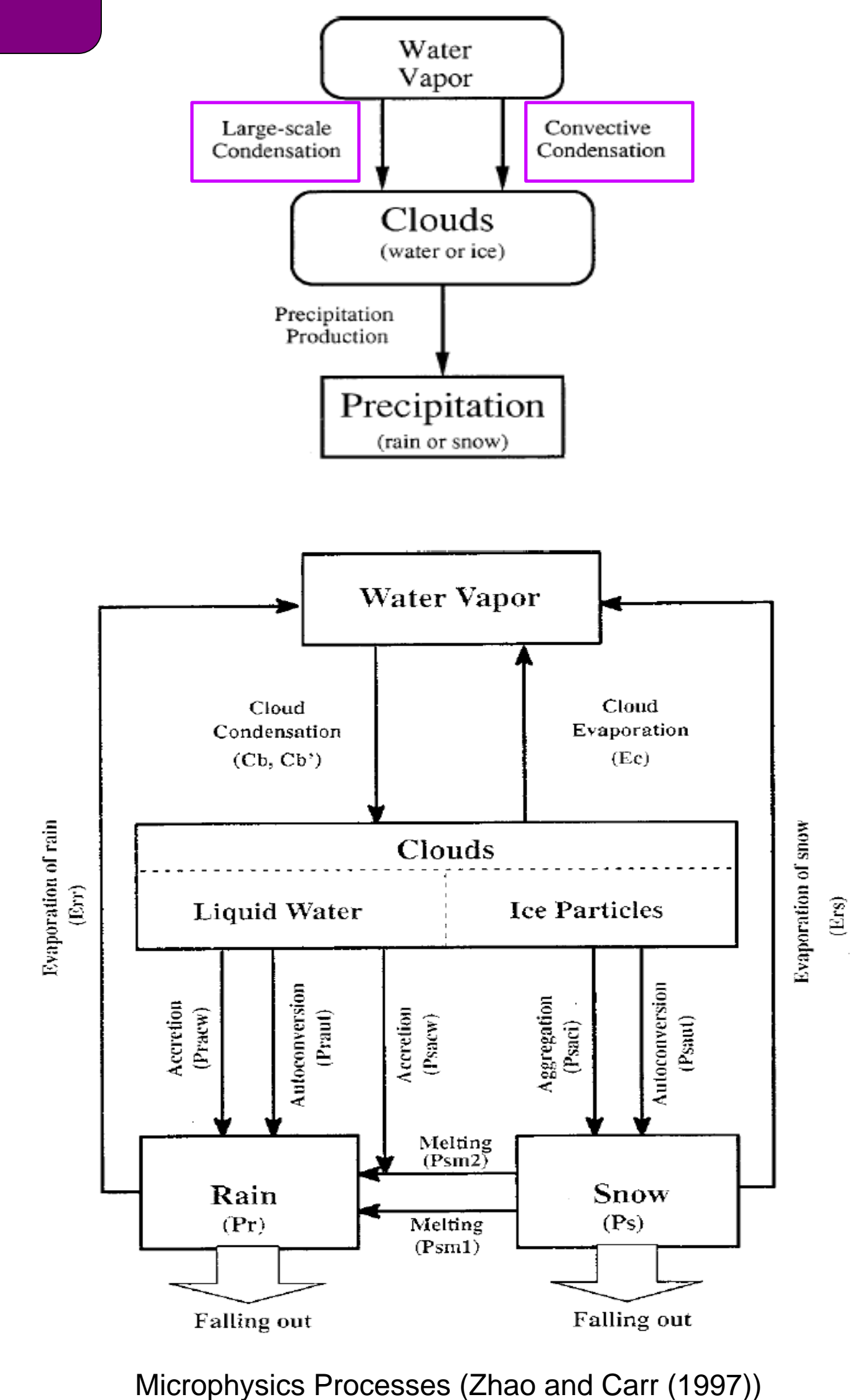
- Simplified Arakawa and Schubert scheme
- Convection occurs when the cloud work function exceeds a threshold

$$\text{Cloud work function: } A = \int_{z_0}^{z_T} \frac{g}{c_p T} \frac{\eta}{1 + \gamma} (S_{\text{cloud}} - S_{\text{env}}) dz$$

- Quasi-equilibrium of cloud work function to determine mass flux

Grid-scale Condensation and Precipitation: Zhao and Carr (1997)

- Hydrometeors: cloud water, rain, cloud ice, and snow
- Microphysical processes: condensation, evaporation, accretion, autoconversion, melting/freezing, aggregation of ice crystals

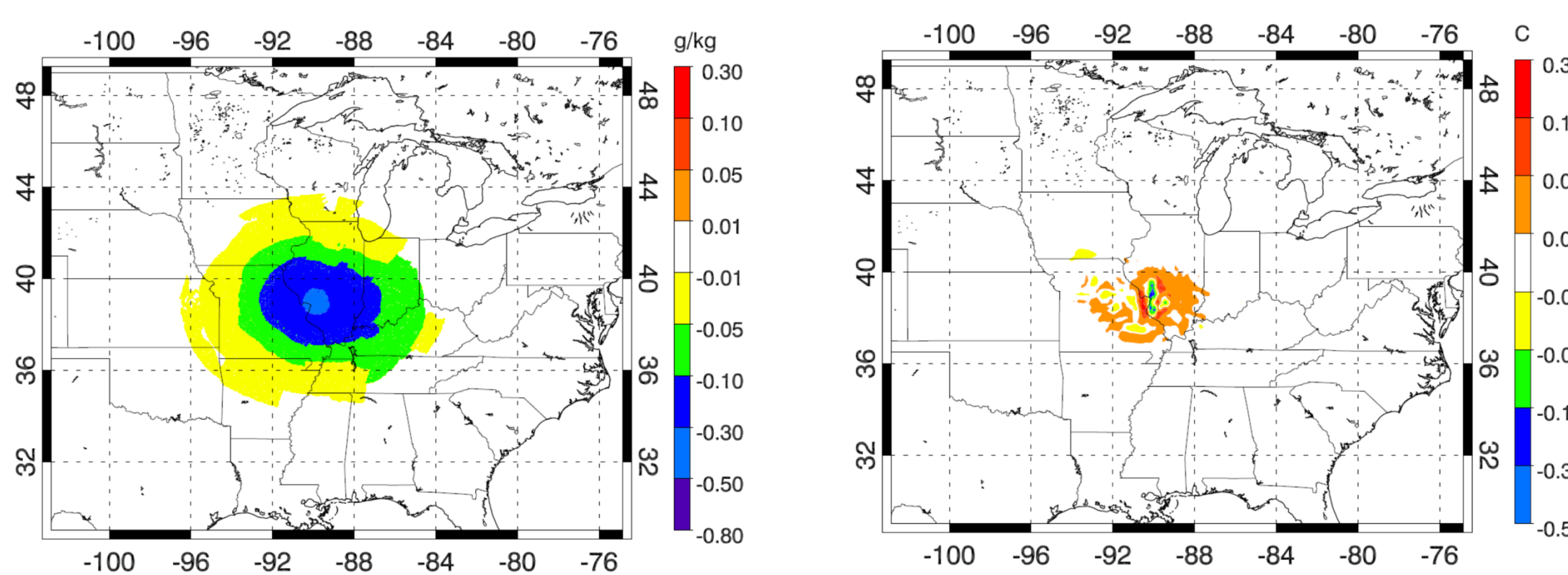


Preliminary Result

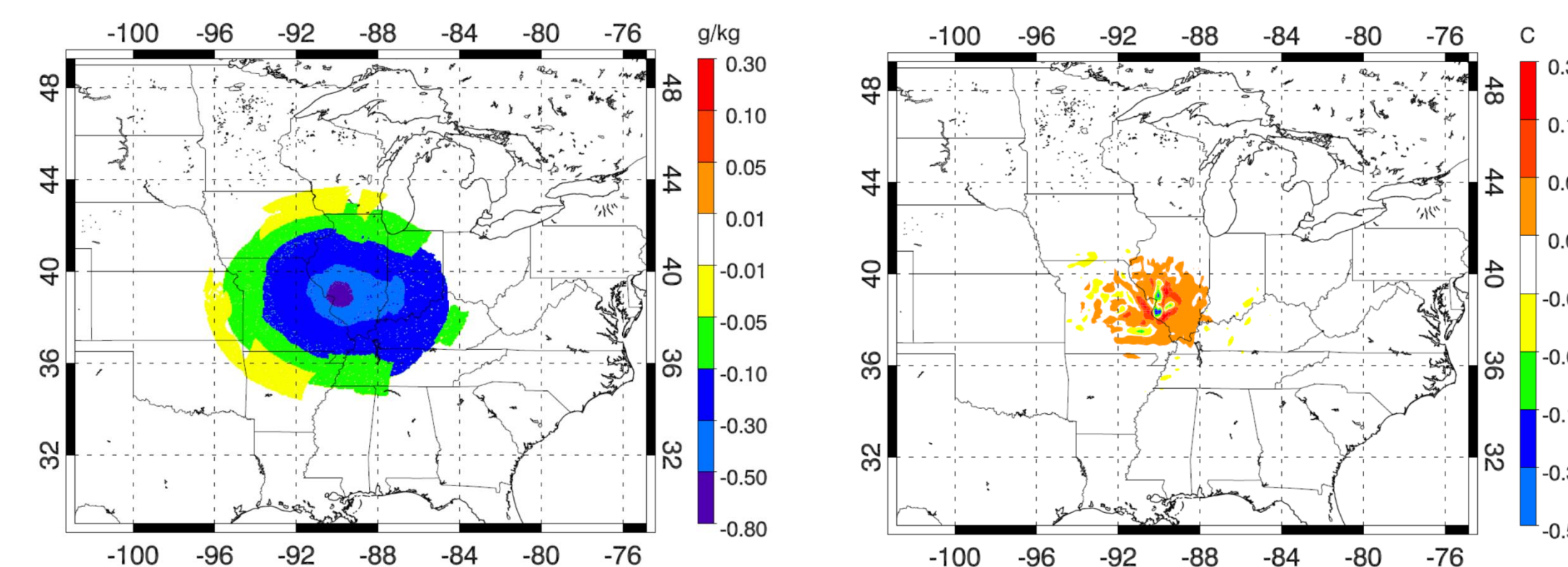
Single Data Test

Observation: 30 mm/hr rainrate at (89.93°W, 39.02°N)

Data Assimilation with Grid Scale Precipitation Forward Model
Increment in q at 850 hPa Increment in T at 850 hPa

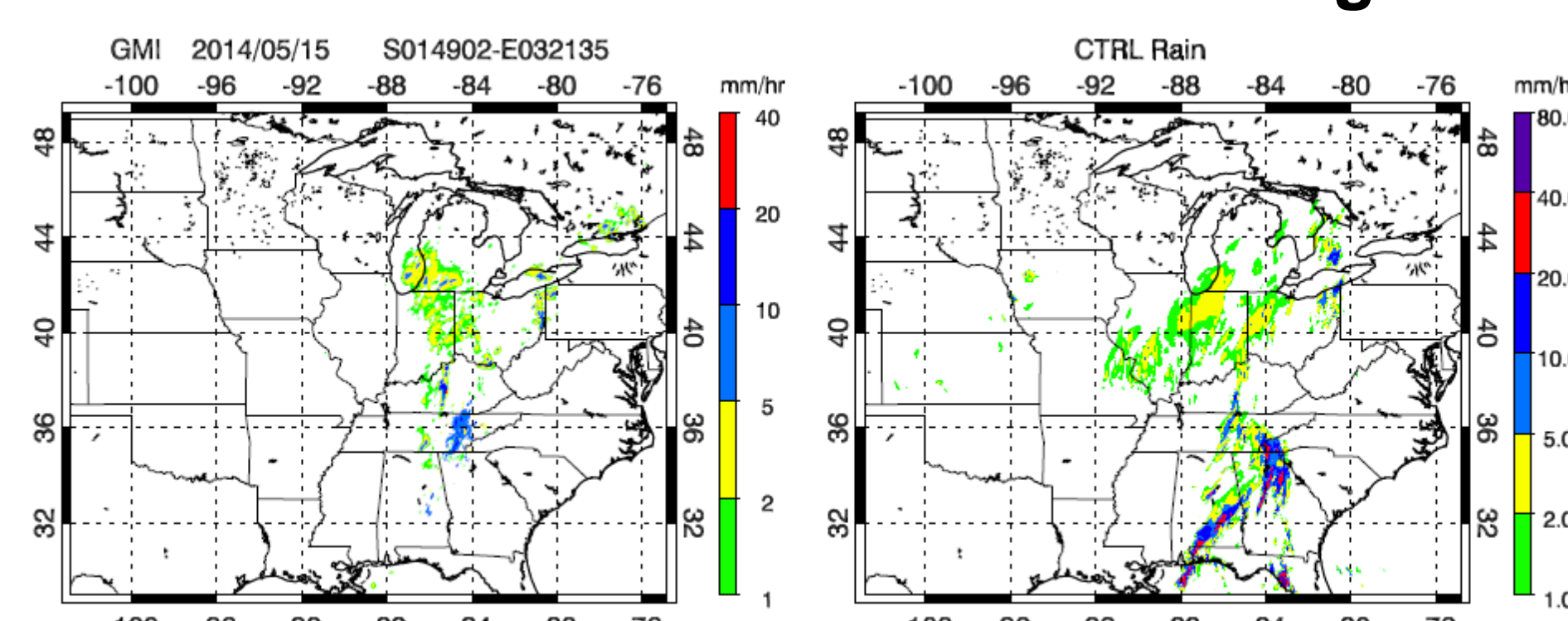


Data Assimilation with Large Scale Convection Forward Model
Increment in q at 850 hPa Increment in T at 850 hPa

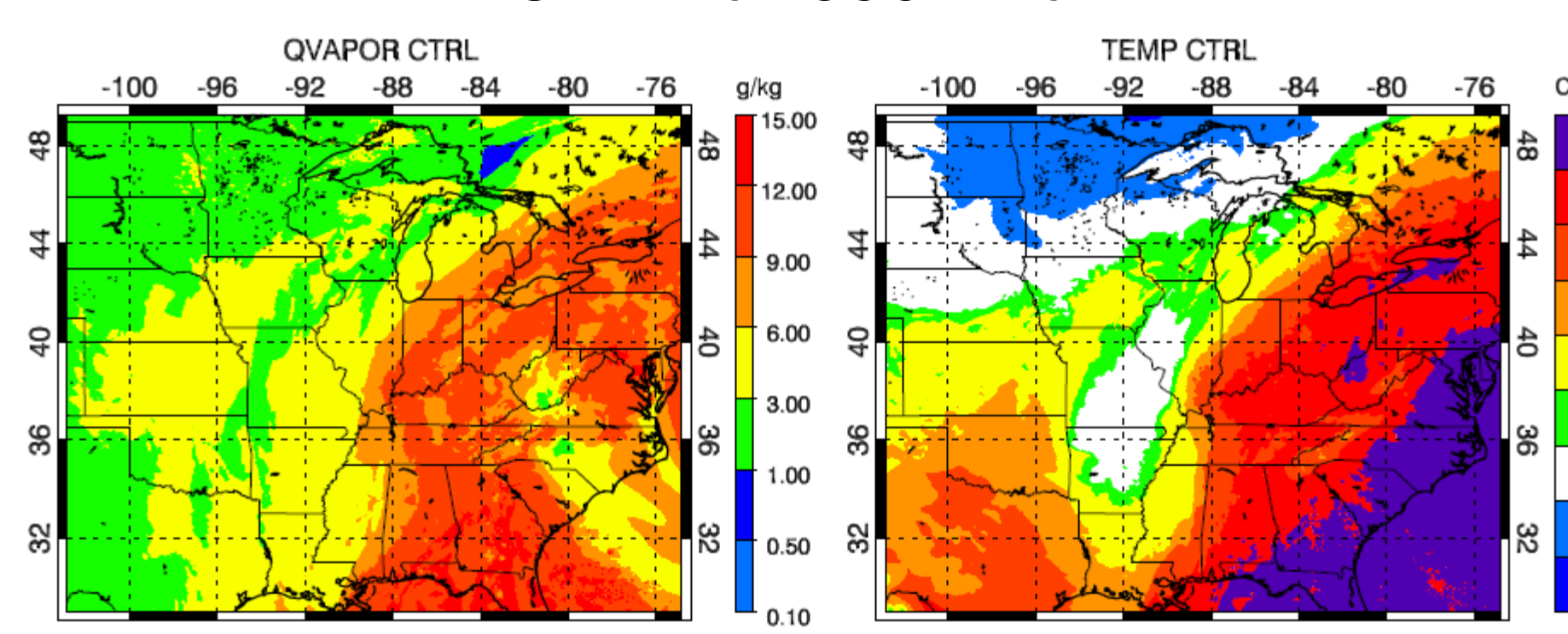


Real Data Assimilation 0300 UTC 2014-05-15

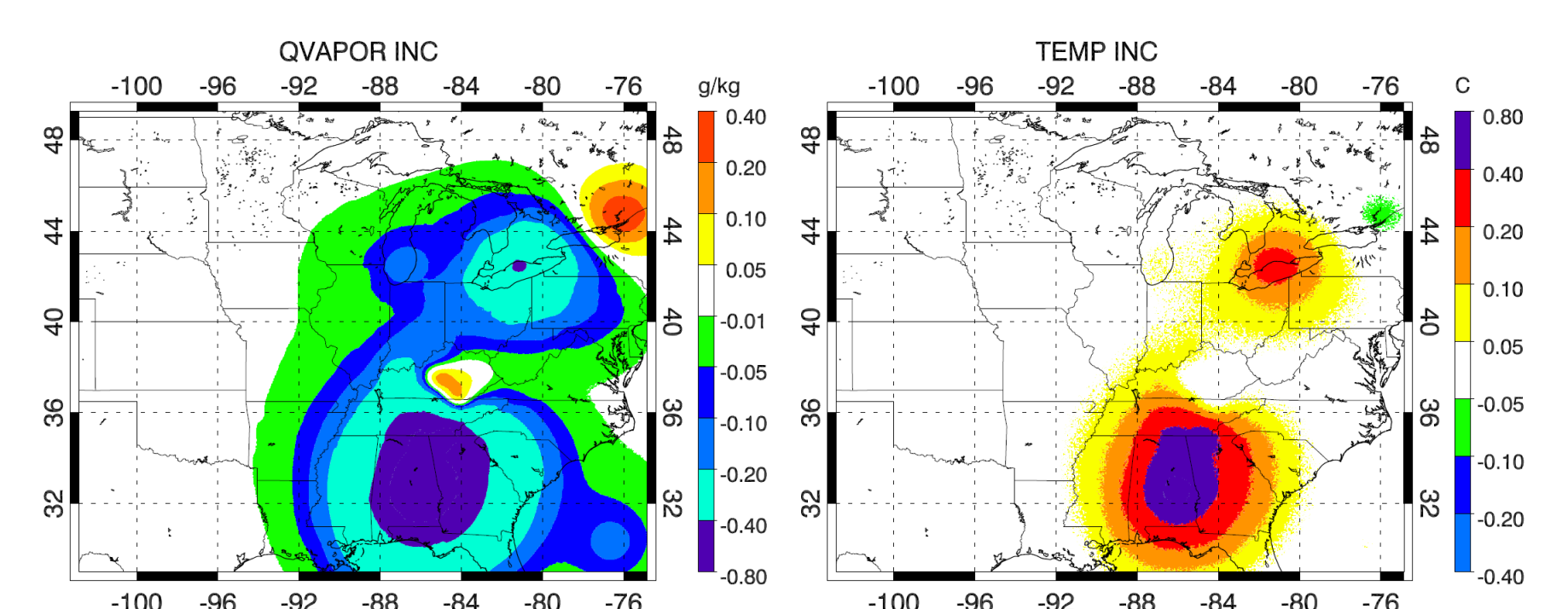
GMI Rainrate Rainrate in Background



CTRL at 850 hPa

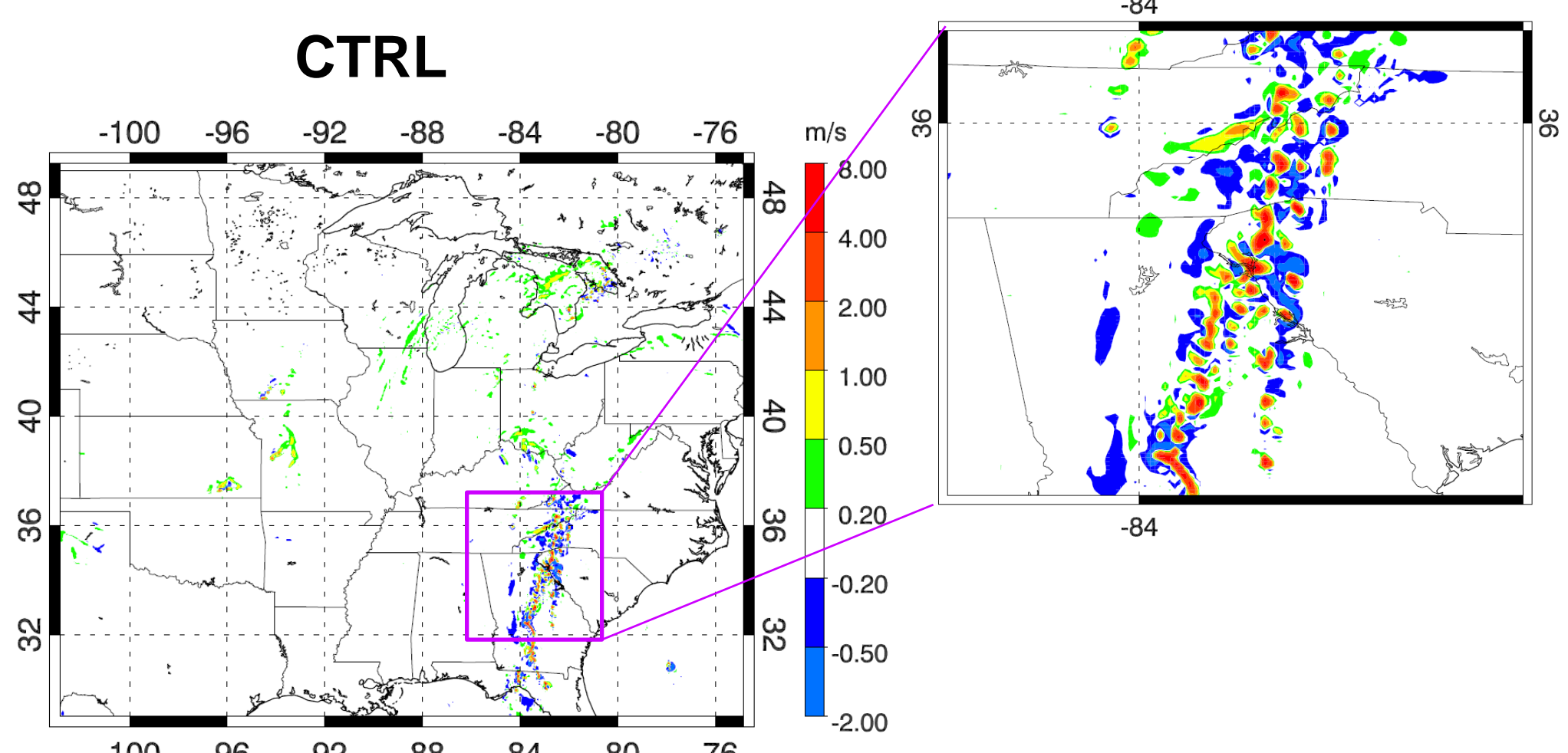


Increment at 850 hPa: DA – CTRL

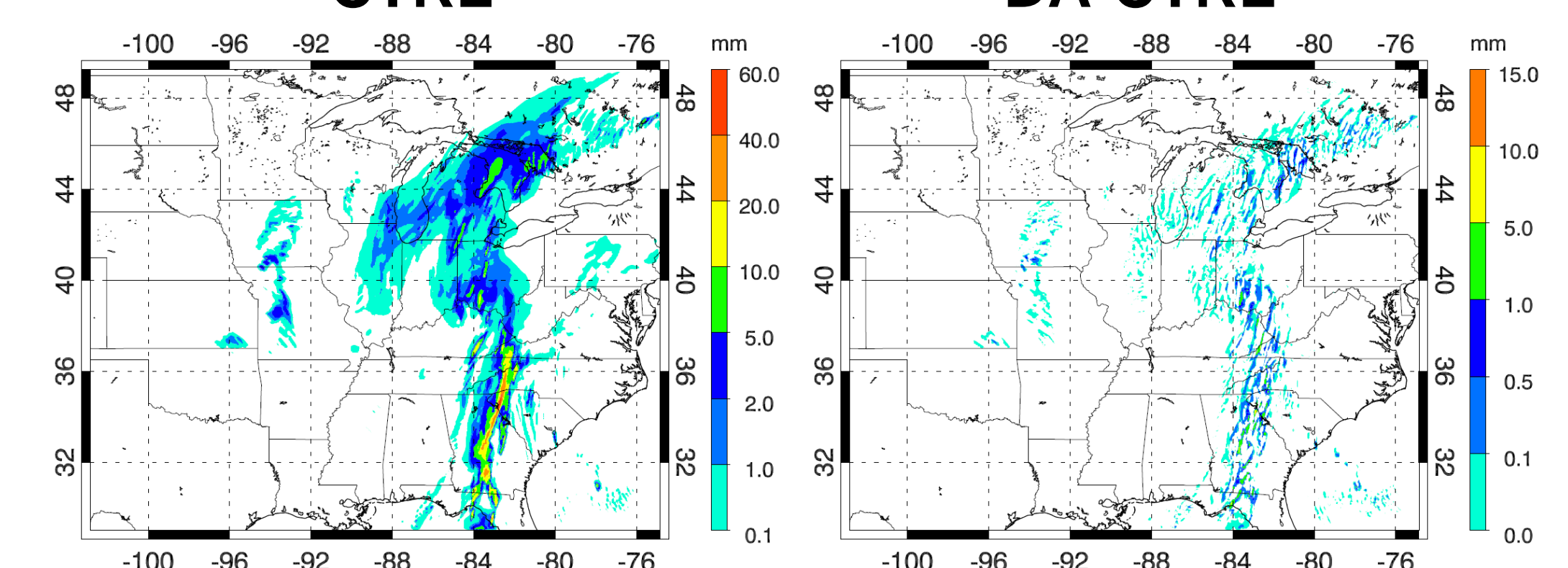


Data Impact in Forecast Fields at 0900 UTC 2014-05-15

Vertical Velocity at 500 hPa



1h Accumulated Rainfall 0800 – 0900 UTC
CTRL DA-CTRL



Discussion & Next Steps:

- Impact of GMI rainrate data on grid scale condensation and large scale convection forward models has been found on temperature and moisture fields with single data test experiment.
- Real data assimilation with a case study for a heavy rainfall event on May 15 2014 showed impact on temperature and moisture fields of initial condition. Impact of the data has been found in 6-h forecast of precipitation and dynamic fields.
- Ongoing: Issues with GSI output of temperature/potential temperature fields for WRF ARW files.
- Continuous assimilation of GMI rainrate and impact verification.

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